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Environmental Tracers for Determining Water Resource Vulnerability to Climate Change

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Disclaimer

Environmental tracers for determining water resource vulnerability to climate change

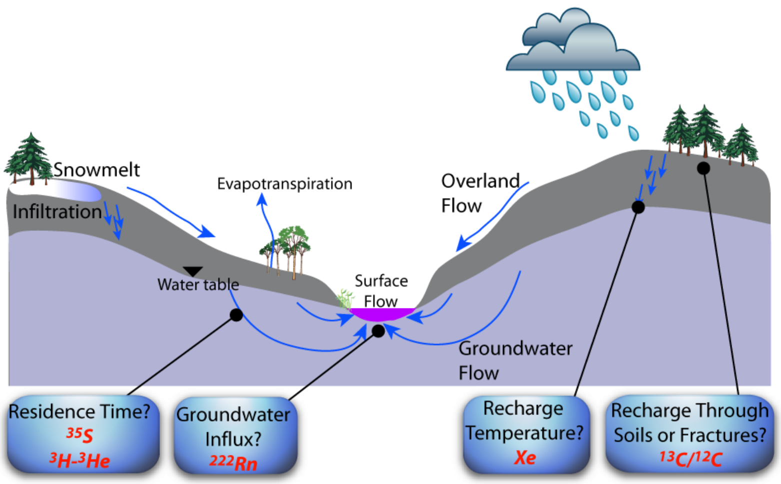
Predicted changes in the climate will have profound impacts on water availability in the Western US, but large uncertainties exist in our ability to predict how natural and engineered hydrological systems will respond. Most predictions suggest that the impacts of climate change on California water resources are likely to include a decrease in the percentage of precipitation that falls as snow, earlier onset of snow-pack melting, and an increase in the number of rain on snow events. These processes will require changes in infrastructure for water storage and flood control, since much of our current water supply system is built around the storage of winter precipitation as mountain snow pack.

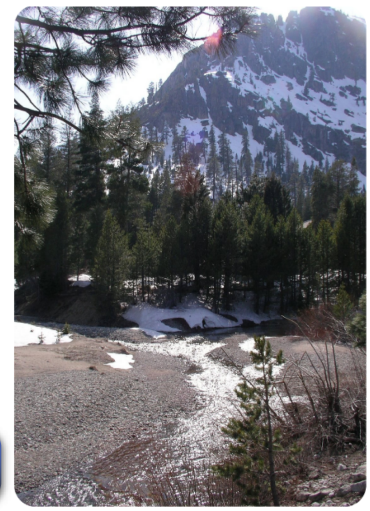
Alpine aquifers play a critical role by storing and releasing snowmelt as baseflow to streams long after seasonal precipitation and the disappearance of the snow pack, and in this manner significantly impact the stream flow that drives our water distribution systems. Mountain groundwater recharge and, in particular, the contribution of snowmelt to recharge and baseflow, has been identified as a potentially significant effect missing from current climate change impact studies.

The goal of this work is to understand the behavior of critical hydrologic systems, with an emphasis on providing ground truth for next generation models of climate-water system interactions by implementing LLNL capabilities in environmental tracer and isotopic science. We are using noble gas concentrations and multiple isotopic tracers ($^{3}H/^{3}He$, ^{35}S, ^{222}Rn, $^{2}H/^{1}H$, $^{18}O/^{16}O$, and $^{13}C/^{12}C$) in groundwater and stream water in a small alpine catchment to 1) provide a snapshot of temperature, altitude, and physical processes at the time of recharge, 2) determine subsurface residence times (over time scales ranging from months to decades) of different groundwater age components, and 3) deconvolve the contribution of these different groundwater components to alpine stream baseflow.

This research is showing that groundwater in alpine areas spends between a few years to several decades in the saturated zone below the surface, before feeding into streams or being pumped for use. This lag time may act to reduce the impact on water resources from extreme wet or dry years. Furthermore, our measurements show that the temperature of water when it reaches the water table during recharge is 4 to 9 degrees higher than would be expected for direct influx of snowmelt, and that recharge likely occurs over diffuse vegetated areas, rather than along exposed rock faces and fractures. These discoveries have implications for how alpine basins will respond to climate effects that lead to more rain than snow and earlier snow pack melting.

Naturally occurring isotope tracers allow assessment of the vulnerability of hydrologic systems to climate change.





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